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CTSA IN THE CHEMISTRY PEDAGOGICAL RESIDENCE PROGRAM: TEACHING TRAINING SUBSIDIES

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ABSTRACT

For the teachers to insert the Science-Technology-Society-Environment – CTSA perspective in their classes, they need to know what these terms are about, how their interrelationships are contemplated in teaching. Therefore, as an objective, the teaching of Electrochemistry via CTSA was planned and developed, in order to identify whether it provides educational support for chemistry residents. Eight grantees from the Pedagogical Residency Program of the Degree in Chemistry at a Federal Technological University of Paraná (UTFPR) participated in the qualitative research. They contributed with reflections, answers to questionnaires and group interviews during the development of a CTSA proposal for teaching of Electrochemistry. The results, made according to the discursive textual analysis, showed that the residents understood that working this perspective requires a researcher profile from the teacher, that social issues need to be contextualized and learned that interdisciplinarity is essential to contemplate CTSA relationships.

KEYWORDS: citizen training, scientific literacy, teaching, apprenticeship.

CTSA NO PROGRAMA DE RESIDÊNCIA PEDAGÓGICA EM QUÍMICA: SUBSÍDIOS FORMATIVOS À DOCÊNCIA

RESUMO

Para que o professor insira a perspectiva Ciência-Tecnologia-Sociedade-Ambiente – CTSA em suas aulas, ele precisa saber do que se trata esses termos, como suas inter-relações são contempladas no ensino. Por isso, como objetivo, foi planejado e desenvolvido o ensino de Eletroquímica via CTSA, a fim de identificar subsídios formativos para residentes em Química. Participaram da pesquisa qualitativa oito bolsistas do Programa de Residência Pedagógica de um curso de Licenciatura em Química de uma Universidade Tecnológica Federal do Paraná. Eles contribuíram com reflexões, respostas a questionários e entrevistas em grupo durante o desenvolvimento de uma proposta de CTSA para ensino de Eletroquímica. Os resultados, feitos de acordo com a análise textual discursiva, mostraram que os residentes entenderam que trabalhar essa perspectiva requer do professor um perfil de pesquisador, que as questões sociais precisam ser contextualizadas e aprenderam que a interdisciplinaridade é essencial para contemplar as relações CTSA.

PALAVRAS-CHAVE: formação cidadã, alfabetização científica, ensino, aprendizagem.

1 INTRODUCTION

Teachers can include in their pedagogical practice several teaching perspectives, among which, we highlight Science-Technology-Society-Environment - CTSA, because it contributes to student learning and enables them to make decisions based on the scientific understanding of curricular knowledge. For this acquisition, the teacher needs to provide opportunities in their classes that lead the student to reflect and think about issues related to technological advances that may be present in their daily lives, in society or in the world, such as: computers, cell phones, electronic devices, photography, trains, cars, x-rays, social networks, among others, which can impact society and the environment.

As the individual lives on Planet Earth, it is understood that the demands arising from scientific and technological advances point to the need to incorporate a contextualized and interdisciplinary approach that can correlate science and technology. This alludes to the need for teacher educators to offer initial teacher training opportunities on how to teach chemistry via CTSA during pedagogical practice. Therefore, theoretical and methodological proposals must be made available in undergraduate courses, "[...] in particular, the Science, Technology, Society and Environment (CTSA) relations, which mark scientific development, with emphasis on the repercussions of all kinds of scientific and technological knowledge [...]" (Praia, Gil-Pérez & Vilches, 2007, p. 151).

In the degree in Chemistry, the CTSA relationships worked with academics can contribute to their future pedagogical practice, since there are contents that are complicated and considered by many students as difficult to learn, for example, Cruz & Machado (2017, p. 1) they mention that Electrochemistry, due to "the various concepts that involve the operation of a battery and the generation of electricity", need to be well worked on so that students can understand and explain the existing phenomena.

In Brazil, the National Curriculum Guidelines for the Initial Training of Basic Education Teachers, establishes the National Common Curricular Base (BNCC), a document that regulates what are the essential learnings to be worked on in public and private schools for the stages of Early Childhood Education, Elementary and high school. For this, the licensee needs to develop general and specific pedagogical skills and the skills corresponding to them (Brasil, 2019). What should be considered in initial training, "[...] methodologies, pedagogical or didactic practices specific to the contents to be taught, [...], and that allow the pedagogical mastery of the contents, as well as the management and planning of the process of teaching and learning" [...] (Brasil, 2019, p. 6). In addition, it is also necessary to propose teaching perspectives, methodologies and strategies that allow undergraduates to develop creativity and innovation (Brasil, 2019).

In order to achieve such a demand, in Brazil, political actions linked to the Coordination for the Improvement of Higher Education Personnel - CAPES, a foundation linked to the Ministry of Education, has implemented, for example, the Pedagogical Residency Program - PRP, which aims to improve practical training through the immersion of the student in the Basic Education school, from the second half of their course (Brasil, 2018). For the licentiate to fulfill its purposes, it needs to experience and teach, that is, offer and practice classes with the joint guidance of the guiding

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teacher - university professor, residents - licensors, teacher preceptor - school teacher, how to manage the classroom, plan and execute activities, insert teaching resources into lesson plans (Brasil, 2018).

Accompanying the new demands of science education involves understanding how the relationships between Science, Technology, Society and the Environment are integrated during the teaching and learning processes. This points to the need to provide students with opportunities to plan, prepare and evaluate the activities that are part of the CTSA approach, considering that "there is no quality teaching, nor educational reform, nor pedagogical innovation without adequate teacher training" (Nóvoa, 1992, p. 9). That is, "it is not built by accumulation (of courses, knowledge or techniques), but rather through a work of critical reflection on practices and permanent (re)construction of a professional identity" (Nóvoa, 1992, p. 25).

In the literature, there are several works that contemplate CTSA in teacher training, such as the research by Figueiredo (2011), Nunes and Dantas (2012), Pinto and Maciel (2014), Figueiredo, Rocha and Dutra (2016), Monteiro (2018), München (2019), Sous and Nunes (2021), Brum, Higa and Lorenzetti (2021). To collaborate with the theme, a problem question was proposed: "What is the importance of the CTSA proposal for the initial training of chemistry graduates, members of the Pedagogical Residency Program?". To answer the question, the objective was to plan and develop the teaching of Electrochemistry from the CTSA perspective, in order to identify training subsidies acquired by residents in Chemistry.

2 CTSA IN THE PEDAGOGICAL RESIDENCY PROGRAM

In the 60s and 70s, people began to realize that scientific, technological and economic advances did not provide a linear development for the well-being of society as a whole, added to this, "[...] environmental degradation, as well as the linking of scientific and technological development to war, science and technology became the target of a more critical look" (Auler & Bazzo, 2001, p. 1), which favored, from the year 1970 onwards, the movement called Science-Technology-Society (STS), which "proposes a contextualization of the approach to science teaching in a critical perspective" (Santos, 2007, p. 1).

According to Santos & Schnetzler (2010), STS studies aim to contribute to the formation of a critical citizen, able to respond to social problems that may involve scientific and technological issues, being, therefore, capable of making decisions. According to Santos & Mortimer (2001), decision-making needs to occur in a democratic way with discussions, reflections and actions and not in a technicist way aiming economic advantages, to acquire this knowledge, we corroborate the ideas of Santos & Schnetzler (2010, p. 79-80), that is, the individual needs to understand that science is part of "[...] a social, historical and non-dogmatic process".

In the Science, Technology and Society relations, the scientific education process must contemplate the dimensions of social problems so that, according to Vale (1998), the individual understands Scientific and Technological Education in such a way as to favor a social transformation in a country with dependent economy, therefore, an intermediation needs to be carried out jointly, through the school, of teachers who dominate the scientific contents, who have a political vision.

The teacher needs to be trained to develop knowledge from the STS relationships, be able to explore the dimensions of social problems and their causes in science education, not confusing them with mere examples in a superficial way that do not include problems, because according to Freire (2005), a dialogue is needed to promote awareness in order to lead subjects to act on the issues discussed.

Contextualized dialogue with students is necessary to provide opportunities for them to actively participate in the process of exploring issues elucidated in STS relations, thus, the teacher is not only limited to the example and is able to: "Develop attitudes and values in a humanistic perspective on social issues relating to science and technology; assist in learning scientific concepts and aspects related to the nature of science; and encourage students to relate their school experiences in science to everyday problems” (Santos, 2007, p. 5).

Integrating the STS relations, implies, firstly, training the teacher to exercise this demand, considering that “there is no quality teaching, no educational reform, nor pedagogical innovation without adequate teacher training” (Nóvoa, 1992, p. 9, our emphasis) . In Brazil, public policies have been created to improve the quality of practical training in undergraduate courses, the most recent being the Pedagogical Residency Program (PRP), which offers trainees who are starting the second semester of their courses, internships to develop skills and competencies (Brazil, 2018).

Among the opportunities offered to undergraduates who are part of the PRP, there is, at the end of its conclusion, the validation of mandatory subjects, called supervised internships. In other words, as in all higher education degree courses, which are intended to train teachers for basic education in Brazil, they need to include a minimum total workload of 3200 (three thousand and two hundred) hours, 400 (four hundred) hours need to be distributed in the curriculum of degrees for supervised internship (Brasil, 2019).

According to Tardif (2012), the supervised internship is one of the most important stages in the academic life of undergraduates, as it is the moment to experience, observe, act at school as a teaching professional in their future workplace. Therefore, knowing this environment, as he was a student for many years, he may have acquired, during that period, beliefs, representations and certainties about what it means to be a teacher. Added to this, for Tardif (2012), the issue of teaching knowledge cannot be dissociated from other dimensions of teaching, such as the person and their identity, their life experiences, professional history, their relationships with students, teachers, other professionals in the field. school. Thus, during the supervised internship, the student can understand the articulation between theory and practice, obtain different experiences to improve knowledge and skills to be faced during the profession in the daily classes (Tardif, 2012).

For Pimenta (2012), the internship provides opportunities for the student to build knowledge and skills that are essential for the future professional teacher, as they end up interacting what was seen in theory with practice, thus obtaining knowledge that will provide them with experiences of real work life. In this regard, Pimenta & Lima (2012) point out that moments like these are essential for the undergraduate to understand that theory from practice cannot be dissociated, especially in supervised internship disciplines, because in the internship there is no way to separate theory from practice, because there is not only theory or practice.

In this sense, the Pedagogical Residency Program (PRP), having as its object of study, implement "[...] innovative projects that encourage articulation between theory and practice in undergraduate courses, conducted in partnership with public basic education networks" (Brasil, 2018, p. 1, emphasis added), it was essential to work with the CTSA perspective, because it made more time and space available. Because, the graduates, described as residents in the PRP, are paid scholarship holders, and have eighteen (18) months to meet the program's objectives, and must fulfill a “[...] total of 440 hours of activities distributed from the following form: 60 hours for setting up at school; 320 hours of immersion, 100 of which will be conducting, which will include the planning and execution of at least one pedagogical intervention; [...]” (Brasil, 2018, p. 1-2). In addition, the resident has “[...] 60 hours to prepare a final report, evaluate and socialize activities” (Brasil, 2018, p. 2). After completing the required hours, the university professor, coordinator of the program, validates the supervised internship disciplines of the residents.

3 METHODOLOGY

This research is an excerpt from a Course Conclusion Paper (TCC) by researcher Mendes (2018), we prioritize the qualitative and exploratory type; in data collection, essay questionnaires were applied, containing open-ended questions, which allow obtaining information on the participants' perceptions of what is questioned. Another instrument used was the group interview, known as focus group, in which the researcher acts as moderator and conducts it, and there may be one or more moderators, for this, “[...] the subject is introduced with a generic question, which is detailed until the moderator realizes that the necessary data has been obtained. [...]” (Gil, 2008, p. 115).

The group interview was prioritized in order to better understand the investigated problem, “[...] to generate hypotheses and provide elements for the construction of data collection instruments. But they can also be used to investigate a topic in depth, as occurs in research designated as qualitative” (Gil, 2008, p. 114). The group interview was electronically recorded, because “[...] it is the best way to preserve the content of the interview. But it is important to consider that the use of the recorder can only be done with the consent of the respondent” (Gil, 2008, p. 119).

The research participants were 08 academics from the Chemistry Degree course at a Federal Technological University of Paraná (UTFPR), Brazil, all PRP scholarship holders. This group was chosen and contemplated, because they needed to learn the CTSA perspective, to contemplate it in classes during the regency period. To preserve their identity, the letter R (Resident) was used and numbered from 1 to 8; all participated in the development of the study entitled: “Teaching Applied Chemistry to Electrochemistry in the CTSA Perspective”.

The proposals forwarded contemplated the aspects and steps, according to Aikenhead (1990): i) The interaction between science, technology and society; ii) Technological processes; iii) Social issues related to science and technology; philosophical and historical aspects of science; iv) Social aspects of interest to the scientific community; v) Interrelationship between the above aspects. Data collection took place at the UTFPR premises, at night during the residents' stay, on 3 Wednesdays (10/17/2018, 10/31/2018, 11/07/2018). It presents, in a summarized way, what was worked on in each meeting.

3.1 First meeting

Before starting the proposal (10/17/2018; starts at 7:00 pm and ends at 10:40 pm), residents answered two questionnaires. In this research, we present some data obtained in the first one, which contained personal data (name and date of birth), academic data (Period in the Degree in Chemistry) and two questions: 1) Have you heard about CTSA? Comment on your answer. 2) What is CTSA for you? After all residents had answered the questionnaire, an introduction was made via Power Point presentations (Figure 2), asking them the question: "Electronic appliances and household appliances: friend or foe"?

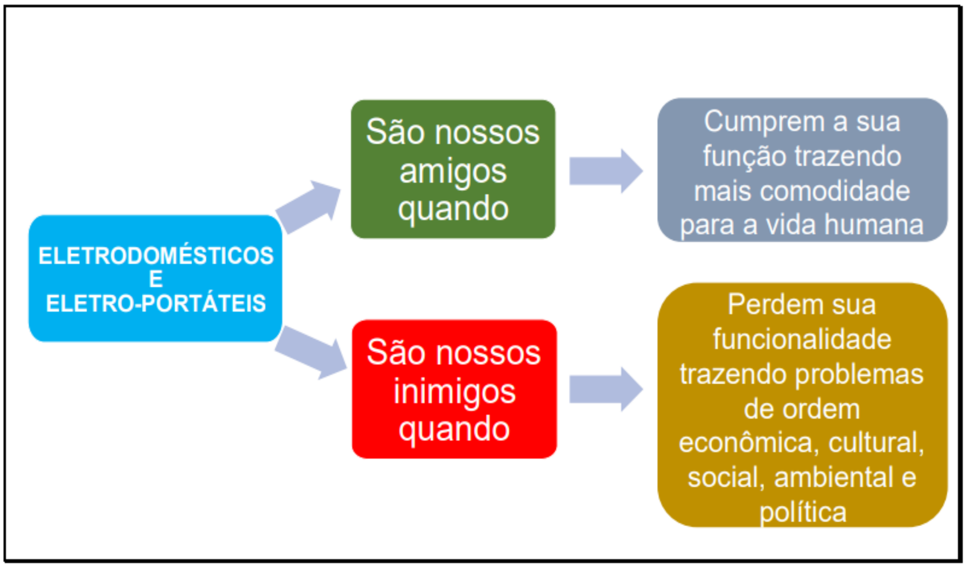

Figure 2: When are household appliances and household appliances friends or enemies?

The residents' answers were noted on the blackboard and contributed to reaching the question of a social problem related to environmental implications: "How to correctly dispose of household appliances and household appliances without harming the environment?" The logic behind this idea was designed to encourage a discussion and to introduce the social issue.

After several dialogues, the residents got to know some household appliances and household appliances through the display of four banners, which can be revisited in Mendes (2018, p. 74-75), they contain information on: radio, television, cell phone and refrigerator, a moment that favored the contextualization of the devices in everyday life. Residents had 20 minutes to collect information on the historical, technological, social, economic and environmental aspects of each device. Subsequently, with the banners of cell phones and radios, a correlation between the cells and batteries was carried out with Electrochemistry, starting this content, which studies the reactions involving the transfer of electrons between the participating species, the so-called oxidation-reduction reactions.

Then, we performed a demonstrative experiment that can be revisited in Mendes (2018, p. 78), in which we teach the reaction between potassium permanganate ($KMnO_4$) and hydrogen peroxide (H_2O_2), working on the blackboard to balance oxidation and reduction half-reactions, and the balanced global reaction. This moment was an opportunity to address the chemical contents related to cells and batteries (battery concept, characteristics that differ from batteries, classification), their characteristics in relation to historical and technological aspects linked to the importance of the technological evolution of these devices to minimize technological problems and environmental issues.

To verify the residents' learning in relation to the chemical concepts worked so far, several activities were applied, the first, contained in appendix C, author Mendes (2018, p. 79), we called it: Find the error! At the beginning, we delivered information on electrochemical cell diagrams, the overall reaction of each, and the model of the electrochemical cell diagram representation for the Zinc-Copper battery of the Power Point presentation, the time taken to find the error, was 20 minutes. Completed, each question was discussed and corrected on the blackboard together with the residents.

The other contents worked were: the Zinc/Carbon dry battery (Invented by the French chemist George Leclanché in 1860; Economic and environmental advantage compared to the Zinc/Copper battery; cathode and anode; reactions in the Zinc/Carbon dry battery and calculation of its potential (Santos & Mól, 2005) And, in the contents about alkaline batteries, the topics were explained: The cathode and the anode in the dry Zinc/Carbon cell; Exchange of the Ammonium Chloride (NH_4Cl) electrolyte for bases strong ones such as Sodium Hydroxide (NaOH) or Potassium Hydroxide (KOH); Advantages in durability and minor leakage problems compared to Zinc/Carbon dry cells; reactions that occur in the alkaline cell. And, in the contents of batteries of Lithium/Manganese dioxide, the topics covered were: Batteries widely used in wristwatches, some types of calculators and in the operation of computer watches; they have good durability, are very light; reactions; potential.

To introduce the battery issues in general, it started with the battery concept, classifications and battery types (Lead/Lead Oxide, Nickel/Cadmium, Lithium-ion and fuel cells), followed by the cathode, anode concepts; Electrolyte; use in automobiles; lead, a highly toxic metal that has a high weight and risk of environmental contamination by Lead; the reactions that take place in fuel cells.

3.2 Second meeting

At the second meeting (10/31/2018; starts at 7:30 pm and ends at 10:45 pm), initially, we carried out a retake of the proposal's progress so far, from the presentation of the theme generator in the form of a question to the end of the Electrochemistry contents related to batteries. Then, we apply a true (T) or false (F) activity, contained in Appendix D in Mendes (2019, p. 80-81). In its development, we used (V) and (F) plates so that the representative of each team could present the answer. And, the teams that made a mistake were asked about their reasoning for addressing the present error and solving doubts. The activity lasted around 40 minutes and aimed to promote a review of Electrochemistry contents in a more interactive and participatory way, to provoke discussions among participants and explore the handling of relevant doubts.

The class continued with an experiment (Mendes, 2018, p. 82), in which residents made a battery potato using a potato cut in half and assembled a system with copper wires containing alligator claws connected to a copper coin and clips. They used a multimeter to measure the potential of the produced cell, and found the direction of the flow of electrons to turn on a small calculator. In this activity, we urge residents to investigate which species participated in the battery reaction, and in assembling the representation of the global reaction. At all times, we carried out a mediation process to gather prior knowledge, so as residents responded, we recorded the information on the blackboard to build potato battery reactions. This activity lasted about 30 minutes, in which we aimed to promote a mediation of knowledge to lead residents to build the reasoning of how the potato battery works, both in chemical phenomena (battery reaction) and in physical phenomena (flow of electrons and electrical potential).

To continue the class, we delivered three images of metallic objects (Mendes, 2018, p. 91), which correlate the coating of metals (galvanoplasty) and its obtainment, for example, aluminum, applications of electrolysis. This moment, it allowed to address the chemical contents of Electrochemistry on the electrolysis, corrosion and electrodeposition of metals, for this, the residents were asked to say what the objects present in the images are. The applications of electrolysis were correlated with household appliances and electroportable appliances and their environmental implications, due to the presence of heavy metals, such as zinc and chromium, present in the coating of components of some of these appliances. The contents about electrolysis covered the topics on: Concept of electrolysis; use in obtaining metals such as sodium, aluminum, iron, and chlorine gas; Representation of electrolytic cell; Igneous Electrolysis; Aqueous electrolysis.

Then, we used images to approach the chemical corrosion and rust phenomenon, inserting the topics: Most metallic structures are made of steel, that is, iron; iron potential is -0.44V, easy to be oxidized; Iron oxidation occurs in the presence of oxygen and water. The rust problem can be minimized with the electrodeposition of metals, an important application of electrolysis, elucidated with the topics: Concept of electrodeposition; Gold electroplating; Quantification of metal deposition, the 1st and 2nd Faraday Laws. We propose some fixation exercises for residents, in order to verify and resolve doubts related to the contents, they were corrected on the blackboard together with the residents.

Next, we worked on an activity entitled: “a deeper look at the recycling of electronic waste” Mendes (2018, p. 83-90), in order to bring economic, social, political, cultural and technological aspects related to the disposal of garbage, and discuss consumption to correlate with the devices studied on the banners and return to the problem question: "How to correctly dispose of household appliances and household appliances without harming the environment?" For its application, we organized the residents in a semicircle and the texts were distributed so as to allow everyone to participate, we made available 10 minutes for reading and collecting the information, at that time, we placed the banners in the classroom to bring their information in the discussion, in order to return to the initial social issue and promote decision-making attitudes.

The ideas discussed were: exhibition of posters about the correct disposal of electronic waste and the problems to human health with incorrect disposal; production of handicrafts with electronic waste; technical visit to the NGO E-Lixo to learn about their work and publicize their work in the community through videos produced and posted on social networks. Due to the time, we ended the meeting at 22:45, with the discussions continuing for the next meeting.

3.3 Third meeting

In the third meeting (07/11/2018; start at 20:00 and end at 22:45), before starting, we delivered to the residents a questionnaire with the essay question: “Describe what are the characteristics of teaching focused on the CTSA perspective?”. At around 8:10 pm, when they finished answering it, we screened the documentary - History of Things, in order to address and promote dialogic discussions regarding the production and consumption of material goods, impacts on the environment and human health, resuming the equation described by López-Cerezo (2009):

+ SCIENCE = + TECHNOLOGY = + WEALTH = + SOCIAL WELL-BEING

After listening to the responses of each resident, the question in the final questionnaire was taken up again to complement their ideas:

Describe what are the characteristics of teaching with a focus on the CTSA perspective?

Finally, we invite you to talk about this:

What is the importance of the CTSA perspective in your initial teacher education?

The group interview ended at 22:45.

The data obtained in the questionnaires and in the group, interview was structured according to the discursive textual analysis - ATD (Moraes & Galiazzi, 2006). The categories were established a priori, according to the theoretical contributions of the CTSA perspective. The analysis started with the transcription of the obtained data, reading and recognition. Afterwards, the deconstruction process continued, at which point the data were separated into units of meaning. Afterwards, in the unitarization, we identified similar data, thus emerging, the subcategorization, in which Moraes and Galiazzi (2006) mention that it proceeds from the analysis and interpretation from the theoretical framework.

4 RESULTS AND DISCUSSIONS

In the first question of the initial questionnaire (Have you heard about CTSA? Comment your answer), we identified that 05 residents had the opportunity to study the subject during the course and in some curricular disciplines, at the University itself, as reported by the answers: “Yes, in the MPEQ1 class we had a discussion and revision of a text about this (R1)”. “Yes, I heard about the CTSA in the subject Methodology and Practice of Chemistry Teaching 1 of the undergraduate course in Chemistry (R2)”. “Yes, this teaching approach was treated as one of the first issues of MPEQ1 (R3)”. “I've heard about academic events, classes in specific teaching subjects, and I've developed some lesson plans in accordance with the CTSA (R4)”. Yes. I got to know the CTSA in the pedagogical disciplines of the course, and I used the approach several times in activities required in these disciplines (R5)”.

In the Degree course in Chemistry at UTFPR, campus Londrina, the CTSA perspective was part of the syllabus of the discipline of Methodology and Practice of Teaching Chemistry 1 (MPEQ1), offered in the 5th period, which proves the answers of R1, R2 and R3. Now, for R7 and R8, they replied that they had never heard of CTSA, this result shows that this subject has been addressed only in this discipline, as the Pedagogical Residency Program began in the 2nd Semester of 2018, before these two students entered that discipline. Another fact is that students can participate in the PRP only from the 5th period of the course, and the said discipline is offered from that period onwards.

We also identified that none of the residents knew about teaching and learning proposals under the CTSA focus in High School. This data corroborates the ideas of Santos & Mortimer (2000), teachers may have difficulties to implement CTSA in the classroom for various reasons, flaws in the pedagogical design and practice during teacher education, not having had the opportunity to learn how to contemplate this approach when teaching curriculum content.

In the answers obtained in the final question: Describe what are the characteristics of teaching with a focus on the CTSA perspective? 09 subcategories and 45 units of analysis emerged from the categories defined a priori: CTSA and Contextualization in teaching (Table 1).

Table 1: Number of Analysis Units by Category

Categories	Subcategory	Number of Analysis Units
CTSA	Social Themes	5
	Problematization	4
	Contextualized approach: interrelationships between science, technology, society, and environment	13
	Student decision making	4
	Interdisciplinary character	1
CONTEXTUALIZATION IN TEACHING	Use of everyday examples to facilitate learning	2
	Relation of scientific concepts with their application in everyday life	4
	Reflection - critical thinking	10
	Globalizing	2

In the category: CTSA, defined a priori, we identified in the subcategory - **Social themes**, five units of analysis (Table 1), which portray that the CTSA approach needs to include a social theme, this understanding is an important point and recommended in the literature, “[...] because they show the interrelations between aspects of science, technology and society and provide conditions for the development of decision-making attitudes in students” (Santos & Schnetzler, 1997, p. 70). This data was evident in the speech of student R5: “[...] the essential thing in CTSA is to choose a topic that is relevant in the social sense [...] that encompasses social, economic, technological aspects, [...] has that enable decision-making by the student [...]”. Therefore, the social theme needs to be thought of to promote the student's immersion in the context to be treated, and to enable interaction between teacher-student, student-student, thus transforming the teaching and learning process.

In the subcategory - **Problematization**, we identified four units of analysis (Table 1), which understand that, in the CTSA molds, it needs to contain the problem, according to some statements:

R4: “[...] Teaching with CTSA occurs through problematizations inserted in the reality of the school, the students, the community”. R2: “[...] a theme with problems to approach and debate knowledge in a contextualized way with students [...] and work the content so that, in the end, students are able to rescue and make a decision about it (the problematic)”.

In the subcategory – **Contextualized approach: interrelationships between science, technology, society and environment**, we identified thirteen units of analysis (Table 1), in this sense, according to Santos & Schnetzler (2010), they mention that teaching from the CTSA perspective needs interrelate science, technology and society to consider their environmental implications. This understanding was verified and confirmed in the responses of: R3: “It is a scientific teaching approach through the correlation between Science, Technology, Society and Environment [...]”. R4: “[...] guarantees to work with contents that simultaneously address aspects of Science, Technology, Society and Environment [...]”. And R7: “It is the combination of different knowledge involving science, technology, society in the development of certain subjects of interest”.

In the subcategory – Student decision making, we identified four units of analysis (Table 1), corroborating what Santos & Mortimer (2001) point out, the STS perspective should favor the decision-making capacity in the search for solving social problems, this knowledge was confirmed in the speech of two residents: “R2: [...] work the content so that at the end the students are able to rescue (the problem) make a decision about it [...]”. “R5: [...] consisting of the presentation of a problem situation and requiring the student to find a solution to the problem, working on the scientific, social and political aspects of the process”. In the CTSA approach, it really needs to highlight the implications of technology in society in a broader view, to understanding these aspects is essential to be able to make assertive decisions.

In the subcategory – Interdisciplinary character, we identified a unit of analysis (Table 1), which is in fact consistent with the CTSA perspective, as its development requires an interdisciplinary study of knowledge, understanding this aspect is fundamental, because interdisciplinarity is "an approach epistemological that allows us to go beyond disciplinary boundaries and enables us to deal, in an integrated manner, with topics common to different areas” (Moraes, 2005, p. 39, emphasis added). This element that is inherent to the CTSA proposal was pointed out in the speech of a resident: “R3: [...] thus enabling a greater awareness of the student involving interdisciplinarity”.

The fact that only one resident understood the interdisciplinary character in relation to how to teach scientific content from the CTSA perspective, allows us to infer that the other residents lacked a more in-depth study about interdisciplinarity. This result was also found by the authors Augusto et al. (2004), when they investigated how teachers in the area of Natural Sciences conceive the concept of interdisciplinarity, concluded that there is a lack of understanding of the meaning of this concept and indicate the need for theoretical reflections in future courses in continuing education of teachers.

In the category: **Contextualization in teaching**, defined a priori, we identified eighteen units of analysis (Table 1), which report to perceptions of contextualization in teaching as the use of everyday examples to facilitate learning, as evidenced in two statements: R7: “Contextualization would be to use everyday examples to explain a certain subject, thus facilitating understanding". And R8: "Bring everyday examples within the content taught in order to facilitate the understanding of students". These statements point to a simplistic view of contextualization, as just exemplifying does not solve problems inherent to the teaching and learning processes. Santos (2007, p. 5), points out that "[...] the simple inclusion of everyday issues may not imply the discussion of relevant aspects for the formation of the student as a citizen or not sufficiently motivate students to become interested in science" [...].

A technicist view was also verified in the speeches of three residents: R4: "Contextualization in teaching is the practice of teaching a certain content according to a certain context". R5: "[...] work on all the content thinking about how the student will be able to apply this knowledge in their daily lives". And R6: "Aims to relate a theoretical content with some everyday event". This view of everyday application of scientific content needs to be reworked, so that in the future professional teaching, they can break away from a traditional mechanical pedagogical practice, which does not allow students to have a critical interpretation of the individual's social reality.

A teaching carried out in the CTSA molds, contextualized, favors the formation of a critical citizen, that is, the individual becomes capable of promoting reflection and critical thinking, this data was verified in the speech of three residents: R1: "[...] make students use their critical sense, connecting the subject with everyday life [...]". R2: "[...] it differs from everyday examples [...] it helps to relate and reflect with everyday life". And R3: "Contextualization in teaching is used to bring a problem involving the student's daily life so that, together with the content, they develop critical thinking". The residents' conceptions inherent to contextualization in teaching reveal that there is still a need to work more effectively on this subject throughout the entire Licentiate Degree course.

In the results obtained in the group interview, we prioritized the category defined as the later one, and four emerged from the residents' answers to the question: "What is the importance of the CTSA proposal in your initial teacher education?"; they are shown in table 2 with their respective units of analysis.

Table 2: Importance of the CTSA proposal for initial teacher training

Category	Number of Analysis Units
1. Important for understanding the student's thinking to promote improvement in teaching performance	4
2. Important for the formation of a researcher teacher	2
3. Important to help develop interdisciplinarity	1
4. Important to establish a relationship of trust and exchange of knowledge between teacher and student	1

We identified that the participation of residents during the CTSA proposal collaborated with their initial training, which can be confirmed in the first category, table 2, as four residents understood that the teacher needs to know what the student thinks to improve their performance as a teacher, notice:

> R3: It's important to make you think about what the student is thinking, to debate with them about the themes within the CTSA to better address the subject.
>
> R5: [...] CTSA has many things. It has the question of growth itself, like the question of debate. Sometimes the teacher is the one who has the knowledge and the debate is also a way for you to get informed, listen to different opinions, sometimes even if the student expresses a common sense opinion. So, with the debate, you can understand why he thinks that way, you can change the way you act and act in the Classroom.
>
> R6: The teacher has to teach how to think, just like people who had the CTSA approach and understand how it works and that makes you think too. So, this will help you think, plan better... and of course, with debates and conversations with students, you will be able to improve as a teacher, in case you reflect on how to be a better teacher, in your teacher training.
>
> R7: CTSA helps to understand the student's way of thinking to find a way, a way to explain the content for him to learn, to bring the knowledge to him, in his line of thought [...], to take the content in a way that the student understands, can assimilate, develop this critical thinking on various themes.

Teaching via CTSA provides opportunities for teachers to mediate knowledge with their students, in the sense of a mutual partnership in which everyone learns together. It also contributes to a relationship of trust and exchange of knowledge between teacher and student, student-student, as seen in the speech of a resident: “R4: [...] I think this (CTSA) also provides a relationship of trust between student and teacher. So a lot of conversation will flow, knowledge will flow, an exchange of knowledge. I think this is important for the content to be fixed, and it is motivating for you to be teaching a class and for you to have a return... you are providing not only the learning of knowledge, but you are also contributing to its formation”. In this speech, we found that, for resident R4, work via CTSA also allows establishing trust between student and teacher as an element capable of breaking down barriers in the teaching and learning process. In the literature, we found studies addressing this issue of considering human conditions - Pinheiro, Silva & Bazzo (2007).

> The teacher is the great articulator to ensure the mobilization of knowledge, the development of the process and the carrying out of projects, in which the students establish connections between the knowledge acquired and the intended in order to solve problem situations, in line with their intellectual, emotional and contextual conditions (Pinheiro, Silva & Bazzo, 2007, p. 77).

We realized that one resident understood that working from the CTSA proposal helps in the development of interdisciplinarity, which is in fact true, because making the interrelationship between Science-Technology-Society-Environment demands that the teacher know other areas of knowledge. Note in your answer: “R1: I think it's important to be able to contextualize the disciplines, pull parts of Physics, parts of Biology, which makes it more interesting [...] interdisciplinary”.

To work specific knowledge from the CTSA approach, the teacher will realize that interdisciplinarity is required, because in discussions with social themes that make interrelationships between Science-Technology-Environmental Society, knowledge from other disciplines needs to be considered to broaden the vision and student learning.

When the teacher inserts the CTSA approach into his pedagogical practice, he advances in his way of acting, especially in the research question, because when thinking about working on social issues, he will need to do research to delineate the contextualization in an interdisciplinary way, which leads him to focus on the teaching and learning needs of the student.

In view of the evidence, we realized that participating in the development of the CTSA proposal allowed some residents to understand the importance of teacher training that would guide them to be a researcher, as this attitude allows thinking of ways to improve the work, according to the testimonies de: R2: “[...] this is what I see as interesting in my education: being updated in the CTSA to bring to the student a problem consistent with what he sees in his life [...]. I must observe, research the issues that currently involve the topics under discussion”. And from R8: “I saw how important this is: with a little effort you can make the student learn more and it doesn't cost much [...] to bring this I have to research”.

Teachers who have the exercise of research in their training can, in their classroom context, problematize, analyze, criticize and understand their pedagogical work, which can produce meaning and knowledge to transform school practices. In this context, we understand that research enables teachers to think about their teaching practice, an essential element to meet new demands in the school context. Added to this, most residents realized that the CTSA proposal allows the teacher to be concerned with meeting the student's needs for better learning, with this, they considered that not only the student is favored, but the teachers too, as they need rethink your way of teaching.

5 FINAL CONSIDERATIONS

In view of the results presented, we found that the residents' perceptions were favorable to the understanding of an approach that includes the CTSA, as they revealed to know some of its fundamental elements, such as social theme, problematization, interdisciplinary character and contextualized approach of interrelationships between Science-Technology-Society-Environment, culminating in the student's decision-making.

Added to this, the analysis of the responses allowed us to verify that participating in the development of the CTSA proposal, contributed to the teacher training of residents who learned that it is necessary to contemplate the student's needs, the teacher's role in having to research to plan, apply and evaluate your classes via CTSA.

We also identified that different views of the subject contextualization in teaching remained, such as the use of everyday examples to facilitate learning, the relationship between scientific concepts and their application in everyday life, and reflection - critical thinking. And the seven residents who did not speak about the importance of interdisciplinarity linked to their teaching training, an element that is present in studies via CTSA, evidencing the need to contemplate the referred subject during the Licentiate course.

The results confirm that there is an absence of the CTSA approach during other curricular subjects of the Licentiate Degree in Chemistry at the university, because we verified that it was worked only in one subject. This fact suggests that professionals who train teachers also lack this understanding so that they contemplate CTSA with licentiates, which could improve the understanding of future teachers on how to contemplate this theme during classes.

The research showed that government programs, such as the Pedagogical Residency Program, are important for undergraduates, because they provide more time and space to train future teachers capable of contemplating elements present in the CTSA perspective in the school context. For future studies, we suggest that residents and teachers in service, apply the proposed - Teaching of Electrochemistry from the CTSA perspective in their pedagogical practices, in order to take ownership of this study in a more practical way, advancing and demystifying doubts that remain about of the subject, mainly in how to contemplate it during the classes.

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